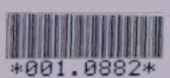
Instruction Manual

Frequency Measurement/FRQ and Integrator Function/INTEG for Model 2533E Digital Power Meter

IM 2533E-50E



YOKOGAWA
Yokogawa Electric Corporation

IM 2533E-50E
1st Edition

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HOW TO USE INSTRUCTION MANUAL

This instruction manual concerns how to operate the frequency measurement/FRQ and integrator function/INTEG which are options for the Digital Power Meter 2533E. Use this manual along with the following instruction manual.

For GP-IB Interface, RS-232-C Interface, Frequency Measurement option: /FRQ and Integrator Function: /INTEG, refer to a separate manual.

Instrument Name	Instruction Manual No.
Digital Power Meter (Single phase, AC, DC/AC)	IM 2533E-01E
Digital Power Meter (Three-phase Three-wire, AC, DC/AC)	IM 2533E-03E
Digital Power Meter (Three-phase Four-wire, AC, DC/AC)	
Frequency Measurement	IM 2533E-50E
Integrator Function	
GB-IB Interface	IM 2533E-51E
RS-232-C Interface	IM 2533E-70E

1. FREQUENCY MEASUREMENT

The frequency of input connected to the voltage terminal (V1 for triple phase model) or current terminal (A1 for triple phase model) is measured. The measurement range is automatically changed from 2 Hz to 200 kHz.

When the filter is ON, the filter of 500 Hz is effective and high frequency components contained in the frequency measurement signal are eliminated. When/INTEG (integrating function) is provided, D-A output of frequency is obtained also.

1-1. Operation for Frequency Measurement

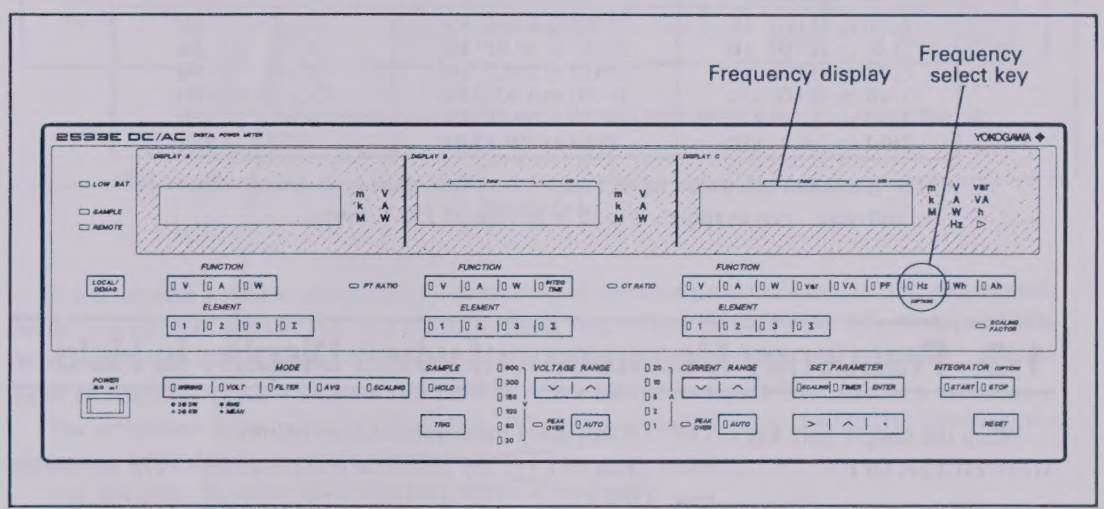


Figure 1-1. Panel for Triple Phase Model.

The frequency can be measured by pressing [Hz] key out of the function keys of DISPLAY C in Figure 1-1.

Pressing the [Hz] key lights up the lamps for the function key [V] and element key [1] in case of triple phase model and indicates the frequency of V1 on DISPLAY C. In case of a single phase model, only [V] key comes on.

Pressing [Hz] again lights up the lamps for [A] and [1] (for [A] only in case of single phase model) and indicates the measured frequency of A1 on DISPLAY C.

During a frequency measurement, pressing another function key (V, A, W, var, VA, PF, Wh, Ah) transfers the control to the corresponding function mode.

- Pressing [Hz] key when the element [2] or [3] of DISPLAY C is selected, the element is [1].

During frequency measurement, neither element [2] nor [3] of DISPLAY C is selectable.

1-2. Frequency Display Range and Display Format

The frequency display range and measurement time are shown in Table 1-1, and the display format is shown in Table 1-2.

Table 1-1. Display Range and Time.

FILTER Conditon	Display Range	Measurement Time
FILTER ON	2.00 Hz to 500 Hz	1.6 s
FILTER OFF	10.00 Hz to 200 kHz	0.4 s

Table 1-2. Display Format.

Measured Data		Display Format
Data Increasing	Data Decreasing	
1.800 to 21.000 Hz	19.000 to 1.800 Hz	○○. ○○○ Hz
21.01 to 210.00 Hz	190.00 to 19.01 Hz	○○○. ○○ Hz
210.1 to 2100.0 Hz	1900.0 to 190.1 Hz	○○○○. ○ Hz
2.101 to 21.000 kHz	19.000 to 1.901 kHz	○○. ○○○ kHz
21.01 to 210.00 kHz	190.00 to 19.01 kHz	○○○. ○○ kHz
210.1 to 240.0 kHz	240.0 to 190.1 kHz	○○○. ○ kHz

- The minimum allowable input range where a frequency is measurable is 10% of full scale. For example, it is 15 V in case of 150 V range.

1-3. Frequency Measurement when Display is Held

When the sample hold key is ON, the frequency measurement is as follows.
When FILTER OFF .....every press of [TRIG] key performs a measurement. The measuring time is 0.4 s.
When FILTER ON .....1.6 s after pressing [TRIG] key, display is carried out.

When the filter is ON, the frequency measurement signal is subjected to a filter of fc=500 Hz (fc: cutoff frequency), which does not affect measurement of V, A or W. This filter is useful when measuring a frequency of PWM type inverter as shown in Figure 1-2. It eliminates influence by the carrier frequency and permits to measure the fundamental frequency only.

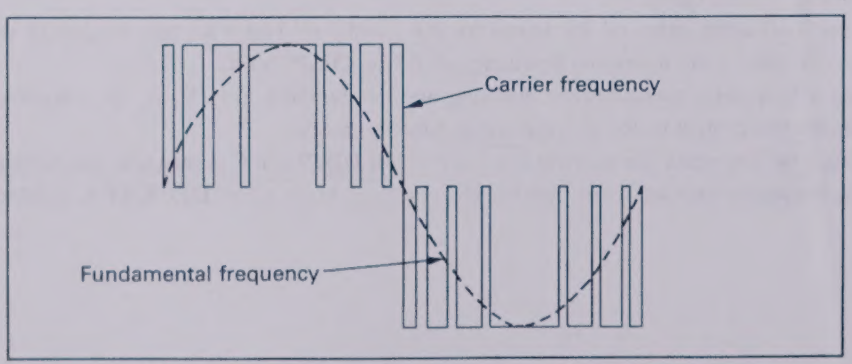


Figure 1-2. Voltage Waveform of PWM Inverter.

2. INTEGRATOR FUNCTION

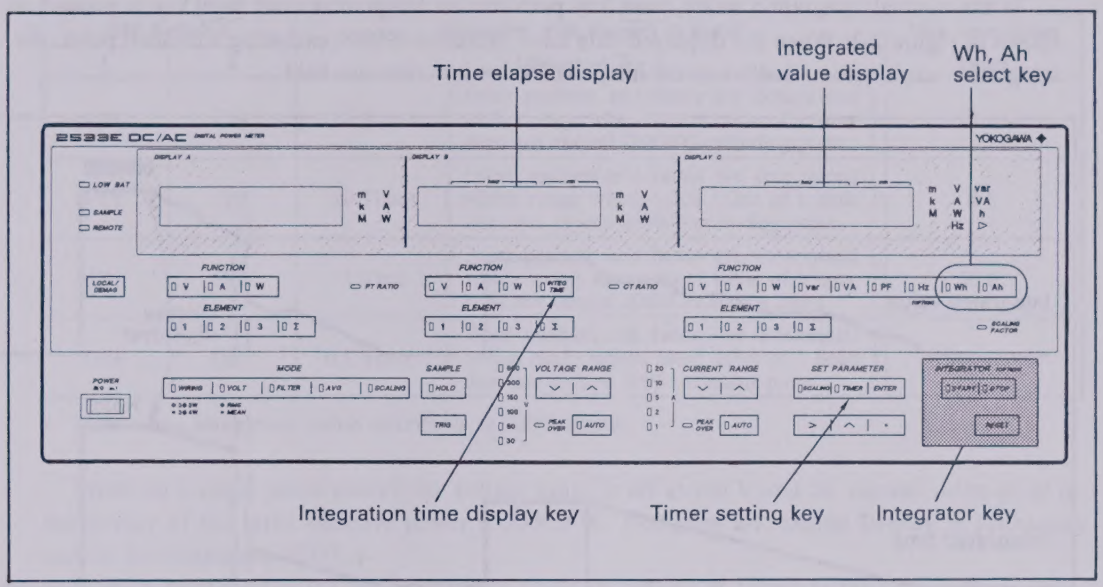


Figure 2-1.

The integrator function carries out an integration of effective power or current. The single phase model can measure Ah and Wh, and the triple phase version can measure Aih, Wih, ΣAh and ΣWh. When validating the integrator function, the integrated value is indicated on DISPLAY C, and the lapse of integrating time is indicated on DISPLAY B as shown in Figure 2-1.

The integrated value is usually increasing. When the measured value is negative, however, the integrated value decreases or is a negative value.

The integrator function has 3 different modes given below.

(1) Manual integration mode
(2) Standard integration mode
(3) Continuous integration mode

2-1. Manual Integration Mode

In the manual integration mode, [START] key performs an integration until [STOP] key is pressed as shown in Figure 2-2. When the displayed data have exceeded 999999 excluding a decimal point, the integration stops automatically and the integrated value and time are held.

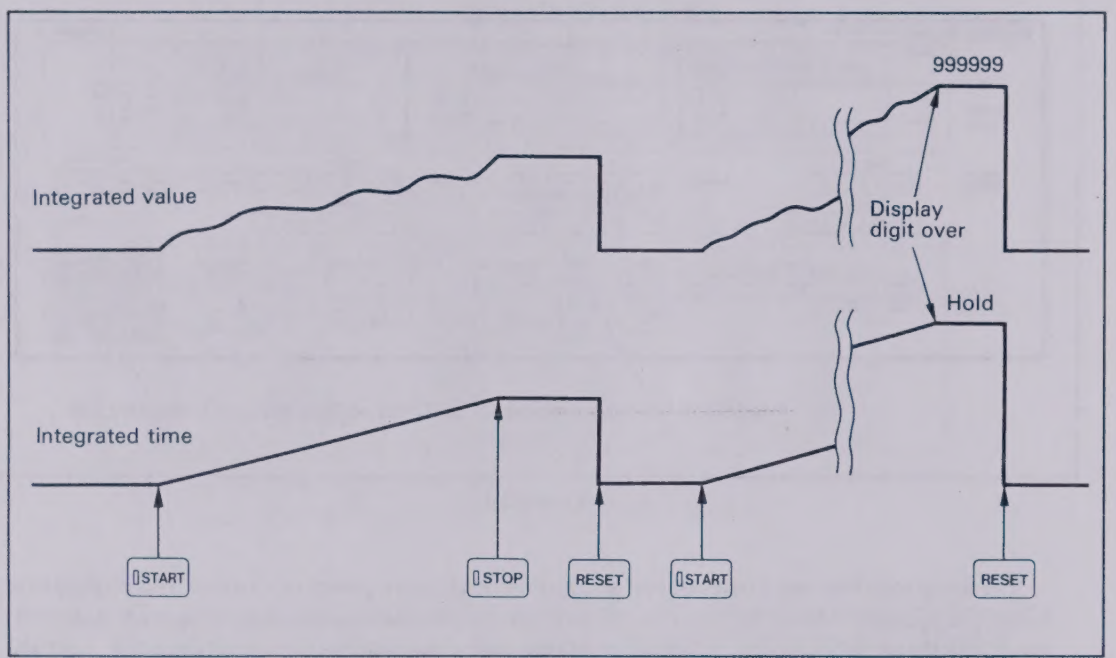


Figure 2-2.

(1) Setting Manual Integration Mode

The manual integration mode is posted when the timer setting on DISPLAY C is 00000 (hour — min). For the timer setting, refer to **2-8. How to Set Timer** page 2-12.

When the instrument is delivered, the manual integration mode is posted.

(2) Setting Display Resolution

The display resolution of displayed value is changeable as shown in Table 2-1 by setting DIP switches on INTEG board in 2533E. For changing DIP switches, refer to **2-10. Setting Internal Switches** on pages 2-16 to 2-17.

Table 2-1.

DIP Switches		Resolution with Respect to Rated Display of W, A	Min. Integration Time*
1	2		
ON	ON	100 Times (Point position and factor are determined within range where rated value of 1 hour does not exceed 2000000 excluding point)	30 min
OFF	ON	10 Times (Point position and factor are determined within range where rated value of 1 hour does not exceed 200000 excluding point)	5 h
ON	OFF	1 Time (Point position and factor are determined within range where rated value of 1 hour does not exceed 20000 excluding point)	50 h
OFF	OFF	0.1 Time (Point position and factor are determined within range where rated value of 1 hour does not exceed 2000 excluding point)	500 h

* Time when integrated value overflows at 100% input.

When on a single phase model, the voltage range is set at 100 V and the current range at 20 A, the display of the rated effective power is 2000.0 W. (Refer to **2-7. Digital Display** in instruction manual for mainframe 2533E.)

When a resolution of 0.1 W is desired in this case, setting of 1 time in the table suffices (min. integration time is 50 h). When a resolution of 1 W suffices, 0.1 time has only to be set. (Min. integration time is 500 h.)

The elapsing time of the timer stops at 999 h. The unit displayed is mWh, Wh, kWh and MWh according to the decimal point.

The setting of display resolution by DIP switches is effective only in this manual integration mode.

2-2. Standard Integration Mode

The standard integration mode is posted by setting the timer. Setting the timer automatically selects a display resolution and performs a display. As shown in Figure 2-3, at time-out (setting time end), the integration terminates automatically and the integrated value and integration time are held.

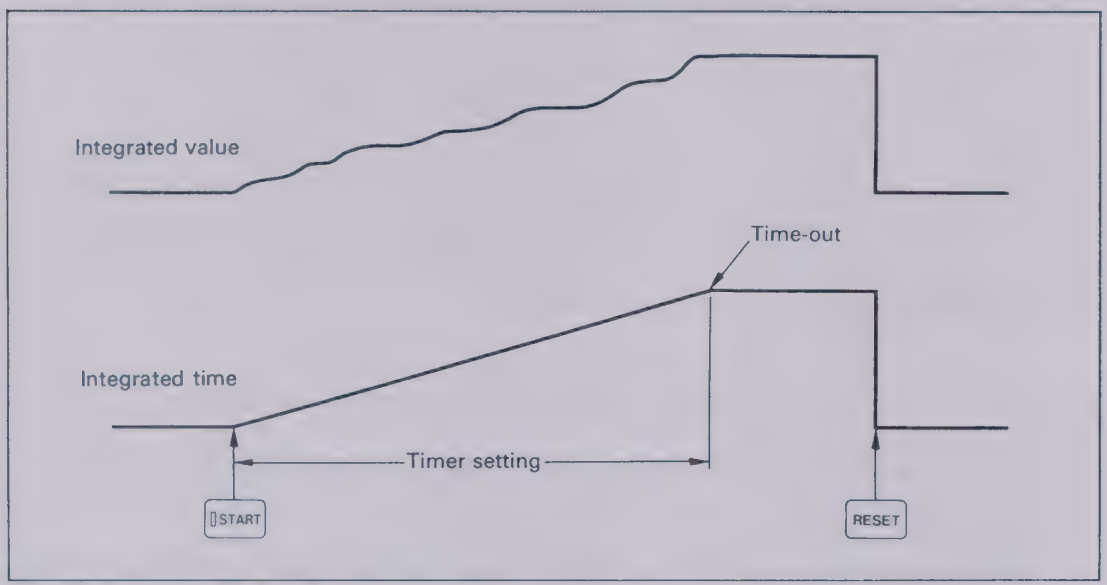


Figure 2-3.

The display resolution is as shown in Table 2-2 according to the timer setting. When the timer is set to 24 hours for example, the display resolution is 0.1 time. Therefore, when a voltage range of 100 V and a current range of 20 A are selected, an effective power of 2000.0 W is displayed, the integrated power is 20000×0.1=2000 W, and the integration is made with a resolution of 1 W.

Table 2-2.

Timer Setting	Resolution with Respect to Rated Display of W, A
00h: 01min to 01 : 00	10 Times (Point position and factor are determined within range where rated value of 1 hour does not exceed 200000 excluding point)
01 : 01 to 10 : 00	1 Time (Point position and factor are determined within range where rated value of 1 hour does not exceed 20000 excluding point)
10 : 01 to 100 : 00	0.1 Time (Point position and factor are determined within range where rated value of 1 hour does not exceed 2000 excluding point)

During integration, manual stop and start are available. In this case, the integration time is not counted while in stoppage and the actually integrating time only is displayed.

2-3. Continuous Integration Mode

The continuous integration mode is posted by changing over the DIP switch on INTEG board in 2533E and setting the timer. Refer to **2-10. Setting Internal Switches** (page 2-16) as for changing over the DIP switch.

As shown in Figure 2-4, at time-out (set time end) of integration, the integrated value and integration time are automatically reset and an integration is started again. At this time, a service request SRQ (INTEG END) is generated on GP-IB. The display resolution is the same as in the standard integration mode.

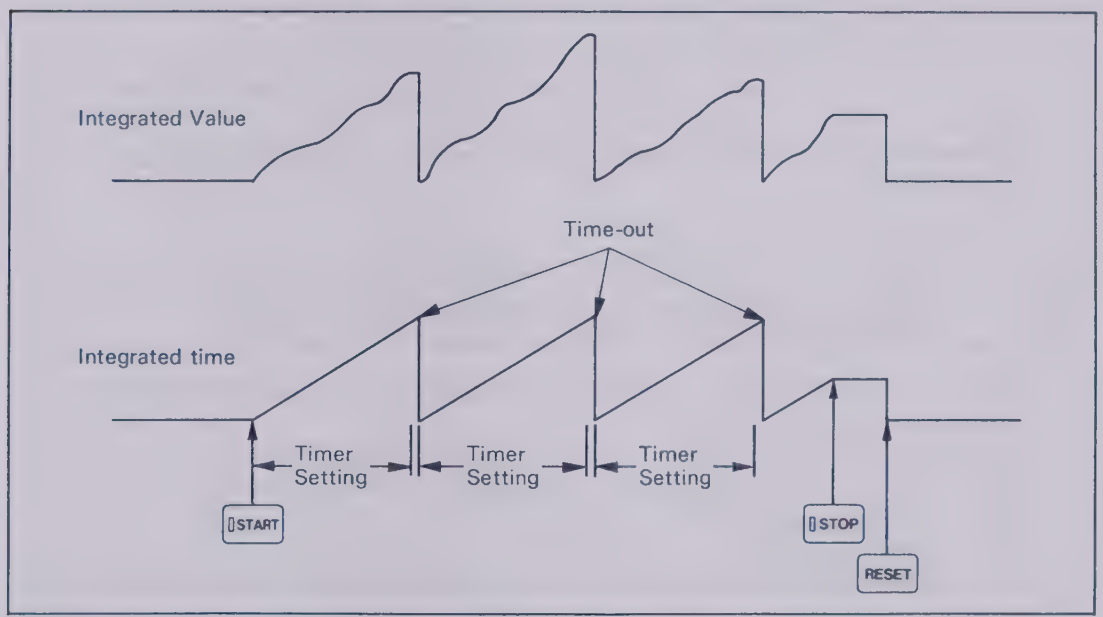


Figure 2-4.

Durning integration, manual stop and start are available. In this case, the integration time is not counted while in stoppage and the actually integrating time only is displayed.

2-4. Backup at Power Failure

If power has stopped during integration, the integrated value and integrating time are prevented from being destroyed. When power has recovered, the integration remains stopped. After power failure, data are held but restart is not allowed. When performing an integration, press the reset key.

2-5. Integration Start, Stop and Reset

The integration is started, stopped and reset by 3 methods given below.

- Integrator key located on front panel of 2533E (refer to **2-7. Operation of Integrator Key**)
- Command of GP-IB (refer to **IM 2533E-50E: GP-IB Interface for Model 2533E Digital Power Meter**)
- Contact closure command of integrator remote control connector (refer to **2-9. How to Use Connector**)

2-6. Integrator Function when Hold is ON

When hold is ON, the display and GP-IB output are held but the integration is executed regardless of whether hold is ON or OFF.

- When an integration is started when hold is ON as shown in Figure 2-5 (a)/(b), the integrated display value remains held and the value integrated up to then is displayed by turning off the hold or pressing the manual key.
- If the integration is stopped when hold is ON as shown in Figure 2-5 (b), the standing integrated value is held and the final integrated value is displayed by pressing the manual key or turning off the hold.
- If power has been suspended while hold is ON, the integrated value and integrating time up to the power failure are displayed. They are not held values. In case of time-out, the integrated value at the time-out is displayed.

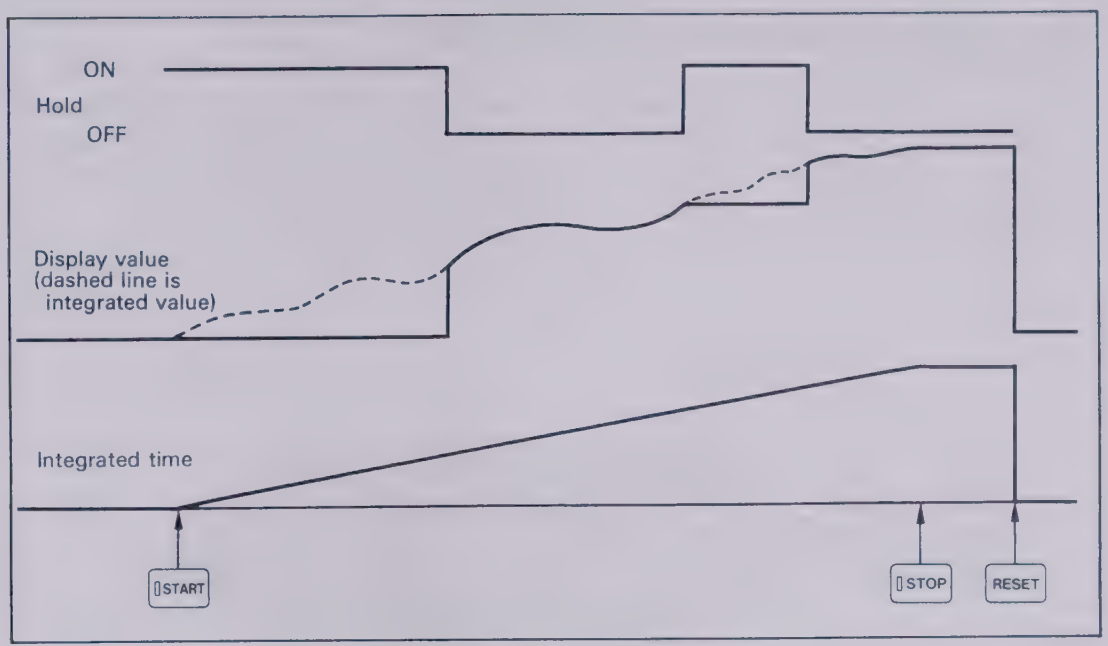


Figure 2-5 (a).

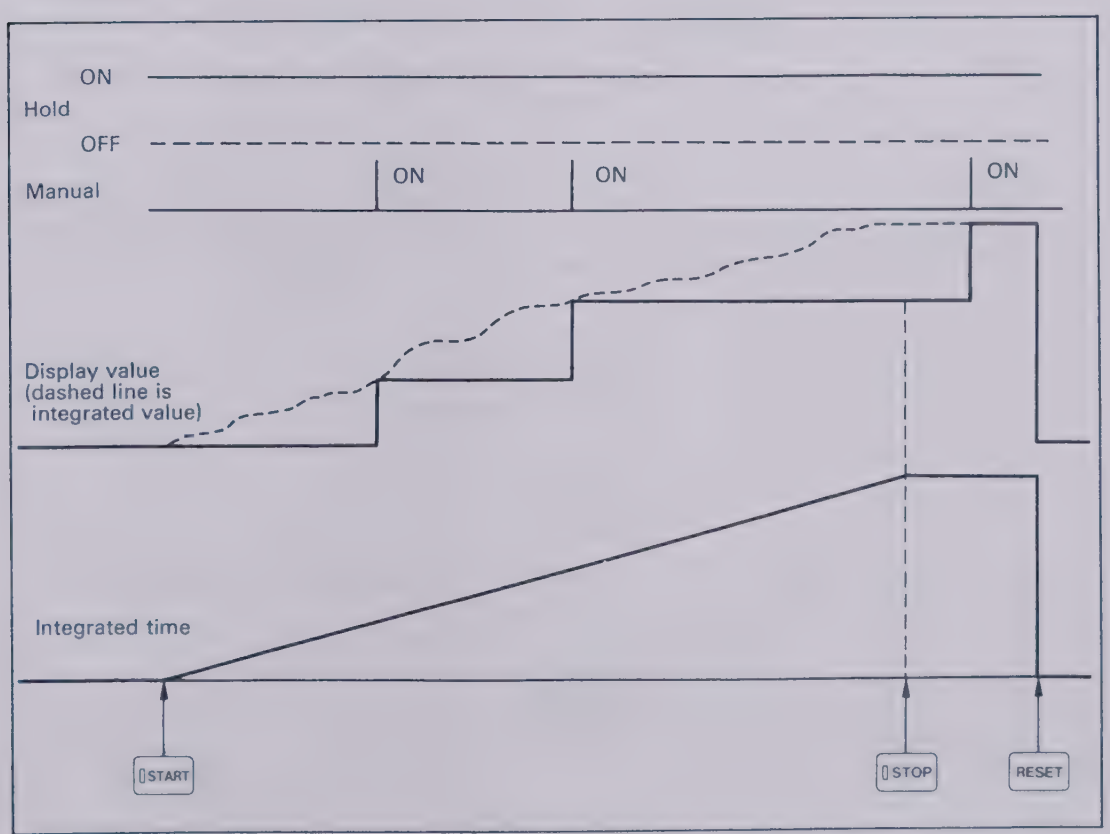


Figure 2-5 (b).

2-7. Operation of Integrator Key

When using an integrator function of Wh or Ah, either NOT RESERVE or RESERVE status is posted according to the internal integrator status. NOT RESERVE is a status where the integrator function is not valid. In this case, the lamps of both [START] and [STOP] for the integrator key shown in Figure 2-1 are extinguished. RESERVE is a status where the integrator function is valid. At this time, either [START] or [STOP] for the integrator is lit as [START] [STOP] or [START] [STOP].

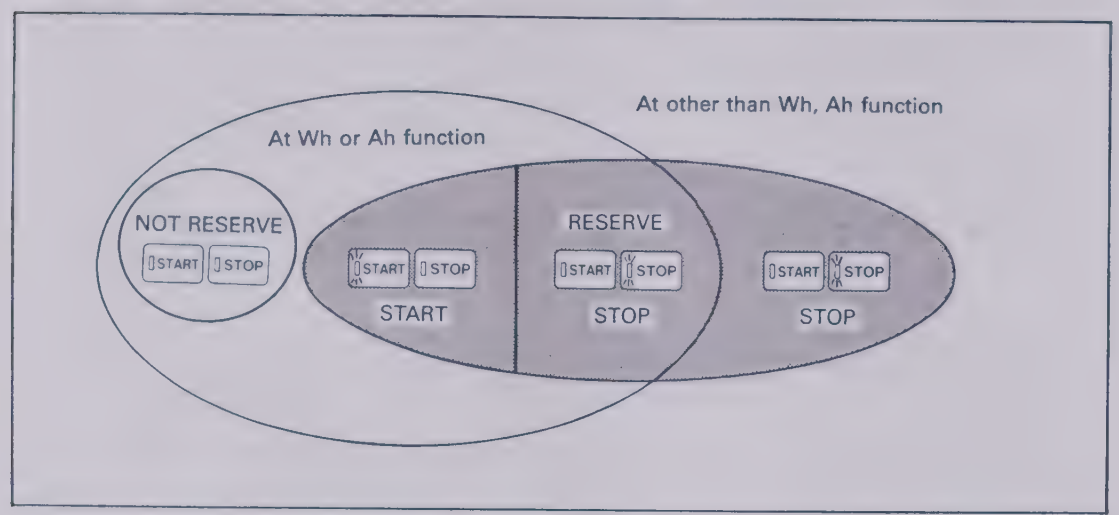


Figure 2-6.

Settings by certain keys on the front panel of 2533 are prevented from changing by touching them during integration. Such a status is shown in Table 2-3. When integrating Wh at RESERVE START status, for example, the display does not change by touching the following keys, that is the keys marked × in the table.

Mode setting keys ..... [WIRING] [VOLT] [FILTER]

Voltage/current range keys ..... [∨] [∧] [AUTO]

Parameter setting keys ..... [SCALING] [TIMER] [ENTER]

[>] [∧] [■]

DISPLAY C function and element keys (triple phase model) ..... [V] [A] [W] [var] [VA] [PF] [Hz] [Wh] [Ah]

[1] [2] [3] [Σ]

Integrator keys ..... [START] [RESET]

The keys marked ○ in the table are freely changeable.

Table 2-3. Triple Phase Model.

Key \ Status		At Wh or Ah Function			At other than Wh, Ah Function	
		NOT RESERVE	RESERVE		RESERVE	NOT RESERVE
			START	STOP	STOP	
MODE	WIRING, VOLT, FILTER	○	×	×	×	○
	AVG, SCALING	○	○	○	○	○
SAMPLE	HOLD, TRIG	○	○	○	○	○
VOLTAGE RANGE / CURRENT RANGE	∨, ∧, AUTO	○	×	×	×	○
SET PARAMETER	SCALING, ENTER, >, ∧, ■	○	×	×	×	○
	TIMER, ENTER, >, ∧, ■	○	×	×	×	×
FUNCTION ELEMENT of DISPLAY A, DISPLAY B		○	○	○	○	○
FUNCTION ELEMENT of DISPLAY C		○	×	○	○	○
INTEG-RATOR	START, RESET	○	×	○	×	×
	STOP	×	○	×	×	×

Single phase model is not provided with WIRING and DISPLAY A, B and C ELEMENT keys.

Typical Operation for Integration

Figures 2-7 and 2-8 exemplify an operation by changing to other function keys during integration. In the figure, (a) indicates a case where the key is locked midway whereby starting is impossible, and (b) indicates a case where an integrator function is available by correct keying.

- If the peak over lamp of voltage and current ranges has illuminated, starting is not allowed.
- In case of peak over or overrange during integration, the integration is pursued as data of up to 150%.

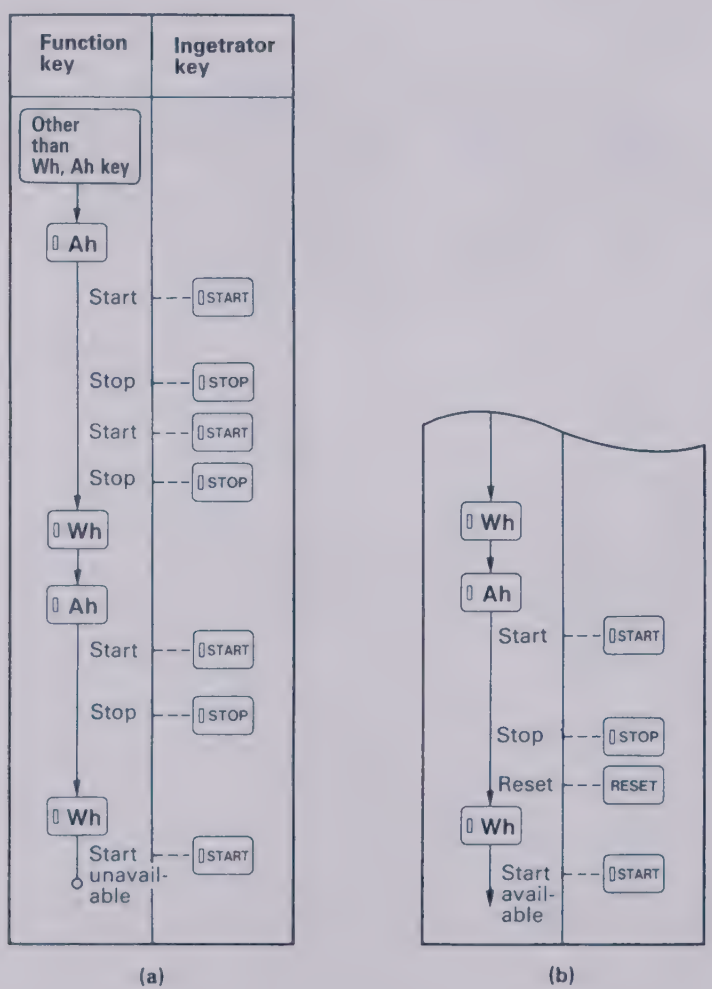


Figure 2-7.

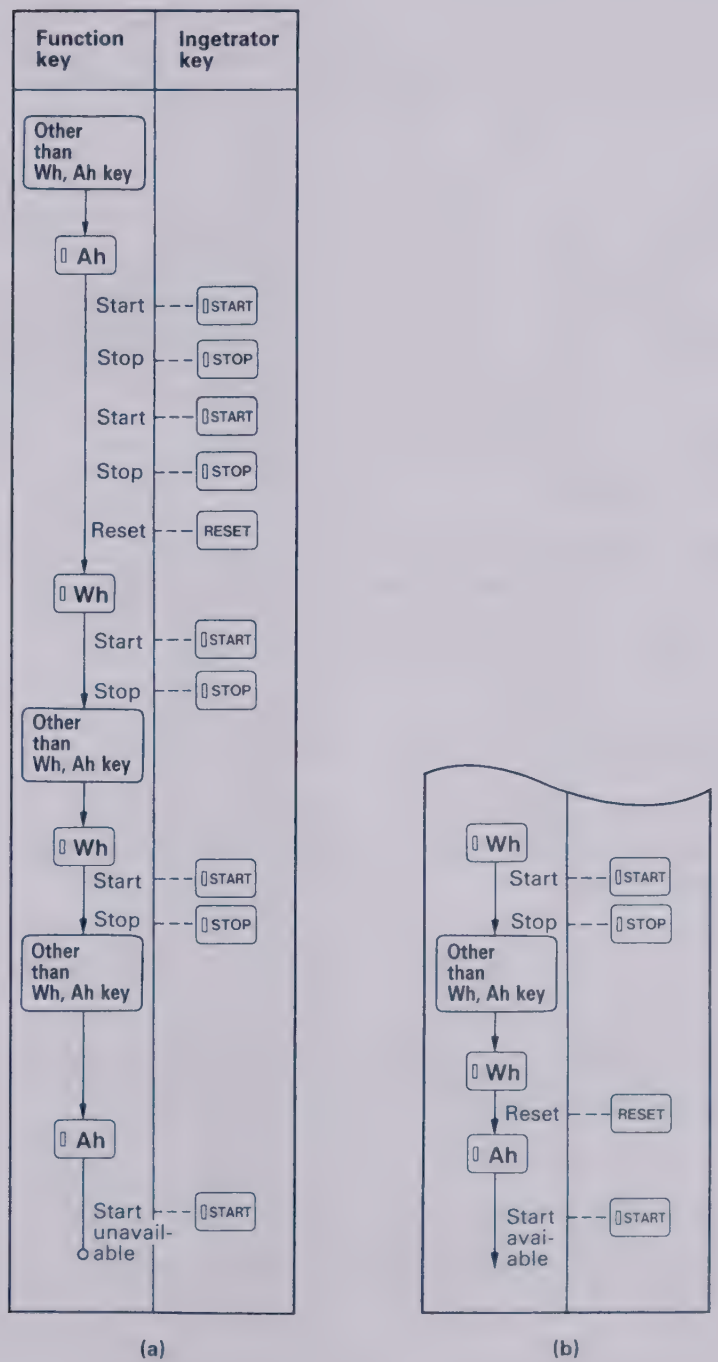

Function key
Ingetrator key
Other than Wh, Ah key
Ah
Start
START
Stop
STOP
Start
START
Stop
STOP
Reset
RESET
Wh
Start
START
Stop
STOP
Other than Wh, Ah key
Wh
Start
START
Stop
STOP
Other than Wh, Ah key
Ah
Start unavail-able
START
(a)
Wh
Start
START
Stop
STOP
Other than Wh, Ah key
Wh
Reset
RESET
Ah
Start avai-able
START
(b)

Figure 2-8.

2-8. How to Set Timer

The timer is set by parameter setting keys marked ▭ in Figure 2-9.

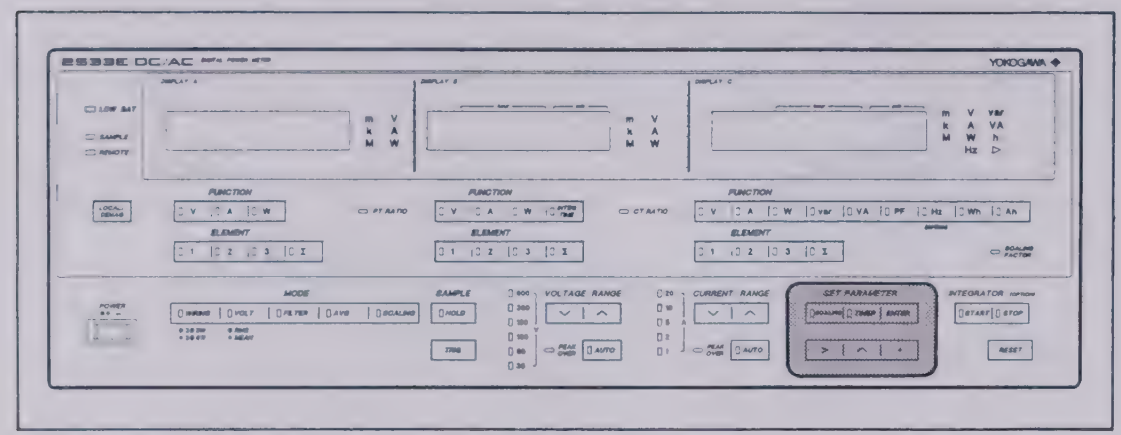


Figure 2-9.

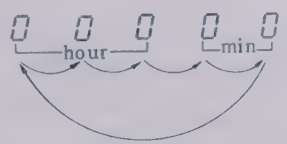
(1) Set the function key of DISPLAY C to [Wh] or [Ah] .

(2) Make sure the lamps for both integrator keys [START] and [STOP] are extinguished. If either lamp is lit, the timer is not settable. When the lamp is lit, extinguish it by [RESET] key.

(3) Operate the parameter setting keys in the following procedure.

[TIMER] : pressing the key constitutes a timer setting mode. At this time, the key lamp comes on, 00000 (hour — min) is indicated on DISPLAY C and the top digit flashes.

[>] : the digit which is changeable flashes. That digit is moved by this key. Every press of the key moves it in the following order. Keeping the key pressed moves the digit in the same order automatically.



[^] : the value is changed. Every press changes the flashing digit in the following order. Keeping the key pressed changes the value in the same sequence.

[ENTER] : the timer setting is entered. Pressing this key, the setting is effective.

2-9. How to Use Connector

The integrator function provided performs the following through an integrator remote control/ analog output connector.

1) Start, stop and reset of integrator function by external signal (refer to 2-9-1.)
2) Analog output of Wh, Ah, Hz, VA, var, PF in display mode of DISPLAY C (refer to 2-9-2.)

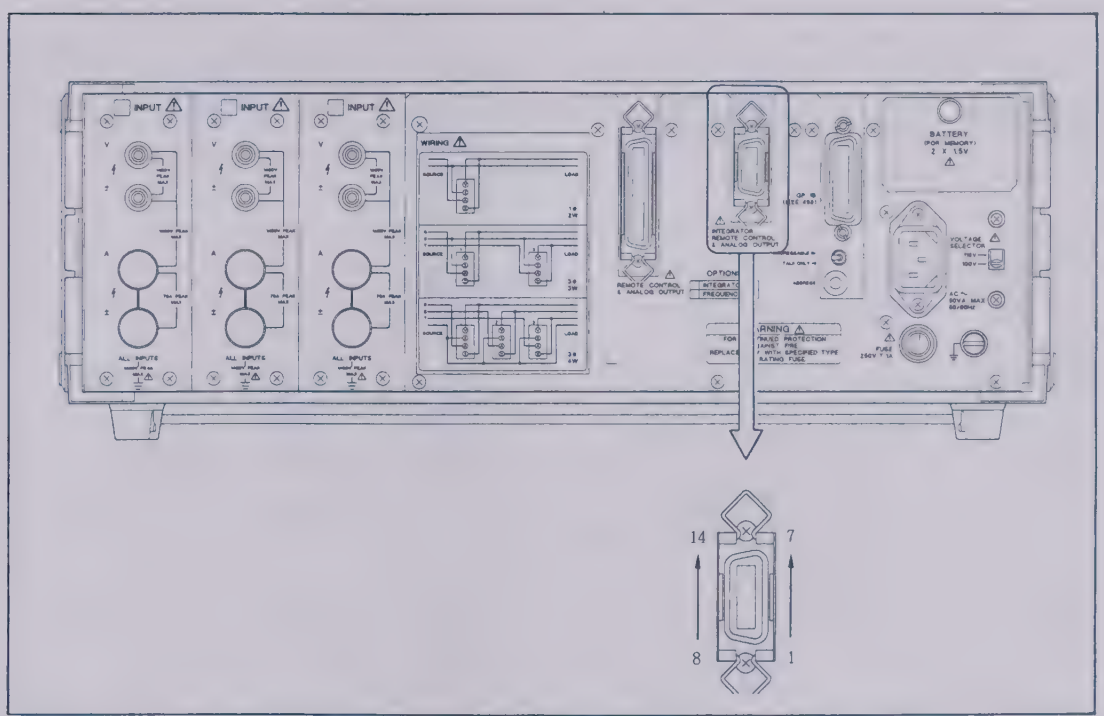


Figure 2-10.

Table 2-4 shows connector pin numbers.

Table 2-4. D-A OUTPUT & INTEG. CONTROL INPUT.

Pin No.	Signal Name	Pin No.	Signal Name
1	DIG. COM	8	+ 5 V
2	DIG. COM	9	
3	EXT. START	10	EXT. STOP
4	EXT. RESET	11	
5	INTEG. BUSY	12	100Hz OUTPUT
6	ANALOG COM	13	ANALOG COM
7	D-A OUT	14	

2-9-1. EXT. START, EXT. STOP and EXT. RESET Signals

When controlling Wh or Ah integrator function by an external signal, the pulse width of the external signal must be 20 ms or more.

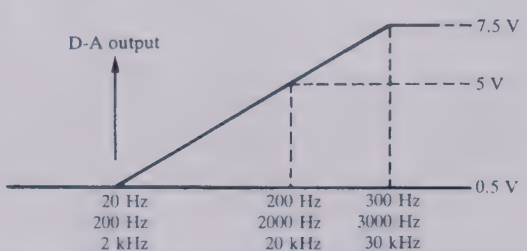
2-9-2. D-A Output

When the display mode of DISPLAY C is Wh, Ah, Hz, VA, var or PF, the relevant displayed value can be D-A converted into analog output. D-A output interval is 400 ms the same as for data display (1.6 s when FILTER ON at Hz). At a hold time, D-A output is also held. When V, A or W other than above is displayed, 0 V is output.

Table 2-5 shows output voltages at different display modes.

Table 2-5.

<table>
<tr><th>DISPLAY C</th><th>D-A Output</th></tr>
<tr><td>V
A
W</td><td>0 V
0 V
0 V</td></tr>
<tr><td>var, VA</td><td>5 V DC is output at rated value (500 var, 500 VA at single phase 100V, 5 A)</td></tr>
<tr><td>PF</td><td>5 V DC is output when PF=1</td></tr>
<tr><td>Hz</td><td>DIP switches on incorporated FRQ board change over AUTO/FIX. For DIP switch changeover, see pages 2-16 to 2-17.
AUTO ..... 20/200/2000 Hz/20 k/200 kHz
FIX ..... 200 Hz, 2000 Hz, 20 kHz
At AUTO

At FIX
 
</td></tr>
<tr><td>Ah
Wh</td><td>
<table>
<tr><th>Resolution at display of rated W, A</th><th>Data output as 5V</th></tr>
<tr><td>10 times</td><td>1 hour rating</td></tr>
<tr><td>1 time</td><td>10 hour rating</td></tr>
<tr><td>0.1 time</td><td>100 hour rating</td></tr>
</table>
</td></tr>
</table>

- D-A output is developed up to ±150% when the rated value is 100%.

Beyond 150%	7.5 V
150%	7.5 V
100%	5.0 V
0%	0 V
−100%	−5.0 V
−150%	−7.5 V
Below −150%	−7.5 V

- An error is output at +7.5 V.
- Figures 2-11 and 2-12 are time charts for D-A output.
  When hold is ON, D-A output corresponds to display. When the display data are renewed by manual start, D-A output is renewed at the same time.

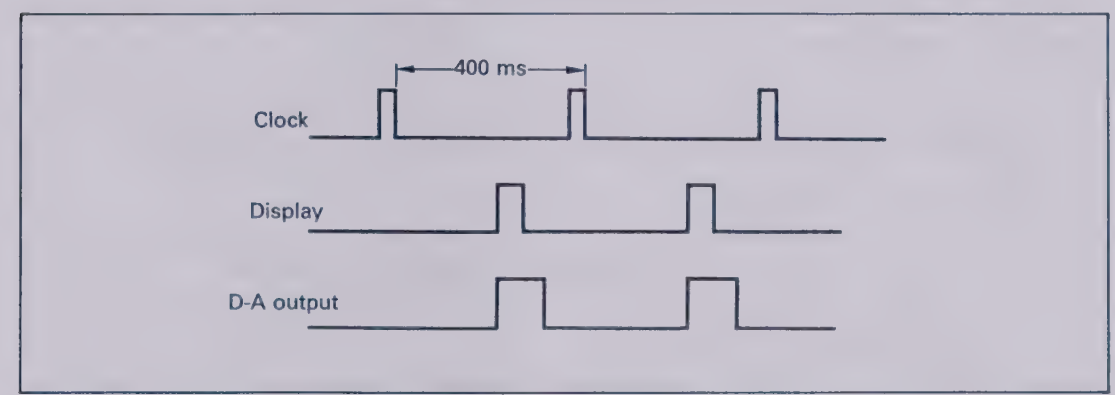


Figure 2-11. When hold is OFF.

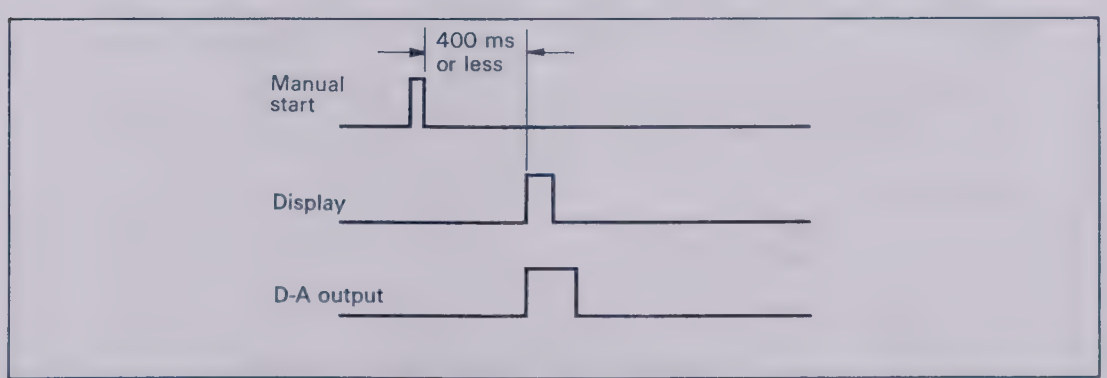


Figure 2-12. When hold is ON.

2-10. Setting Internal Switches

Setting the DIP switches on INTEG and FRQ boards in 2533E performs the following.

INTEG board ..... • Setting display resolution
• Setting continuous integration mode

FRQ board ..... • Setting AUTO/FIX of D-A output (Hz)

INTEG and FRQ boards are installed when designating optional/INTEG and /FRQ, respectively.

Switch Setting Procedure

(1) Disengage the power cord from 2533E. Remove the rubber cover from the side front of 2533E (see Figure 2-13.). When a fixture is attached, remove it by a screwdriver referring to Figure 2-6 in the instruction manual of the mainframe.

(2) Using a screwdriver, loosen 4 screws from the upper case.

(3) Remove the upper case.

(4) Referring to Figures 2-14 and 2-15, set the DIP switches to a desired value. Do not tamper with other parts to avoid a malfunction. Do not admit foreign matter into the mainframe.

INTEG board

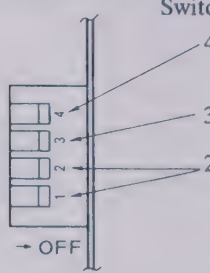

Switch No.
4 : setting of integration mode
OFF: standard integration mode (factory set)
ON: continuous integration mode
3 : OFF
2, 1 : setting of display resolution (effective only in manual integration mode)
OFF

Figure 2-14.

1	2	Display resolution
OFF	OFF	0.1 Time
ON	OFF	1 Time
OFF	ON	10 Times
ON	ON	100 Times

Factory set at 1 time

FRQ board

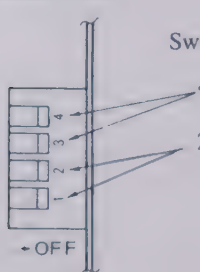


Figure 2-15.

1	2	Frequency range
OFF	OFF	AUTO
ON	OFF	200 Hz
OFF	ON	2000 Hz
ON	ON	20 kHz

Factory set at AUTO

(5) After the DIP switches are set, mount the upper case, tighten the screws and mount the rubber cover or fixture.
Thus, the internal switches have been set.

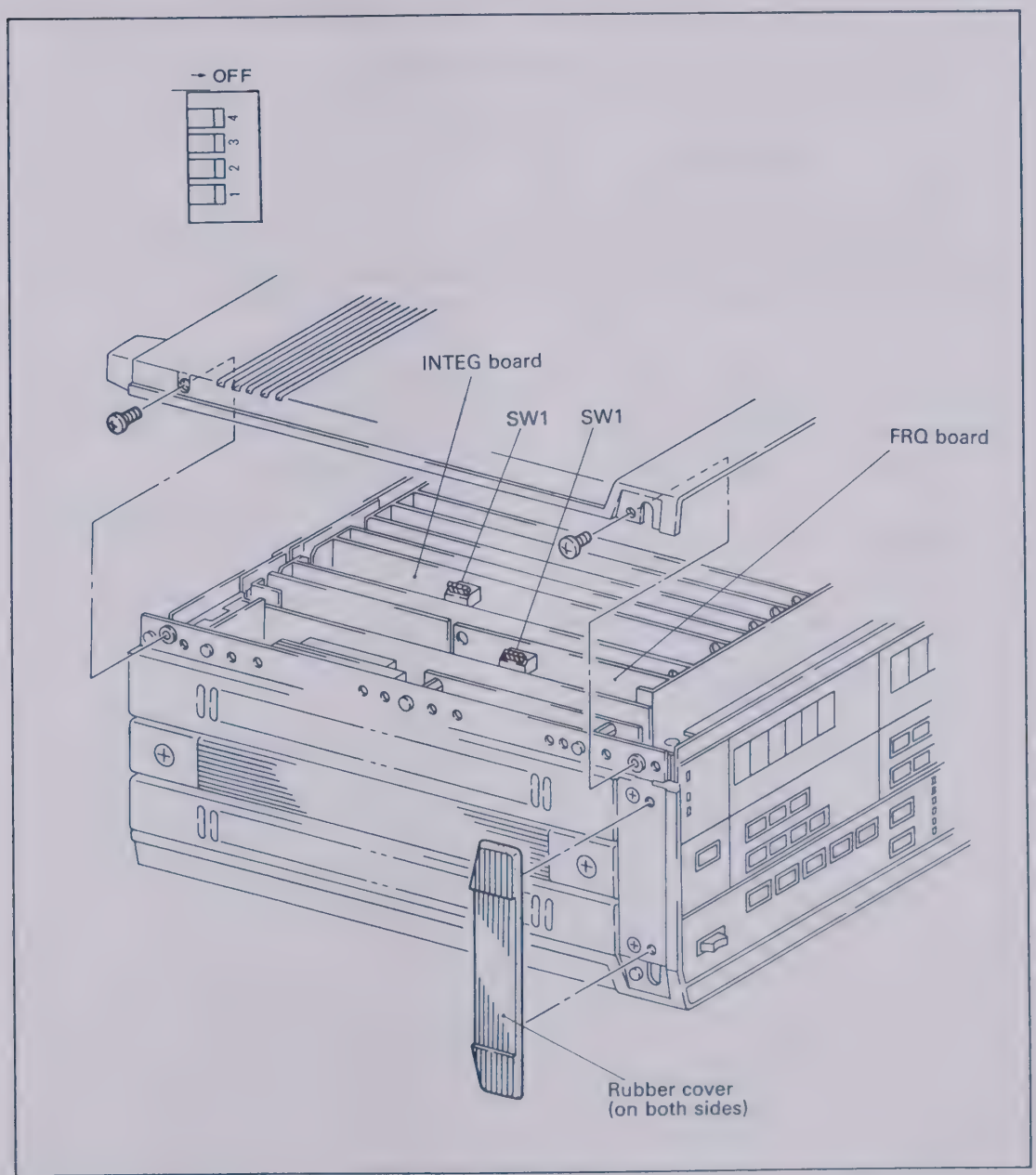


Figure 2-13.

2-11. Integrator GP-IB

For GP-IB function for the integrator function, refer to the following sections in the instruction manual for GP-IB interface (IM 2533E-51E).

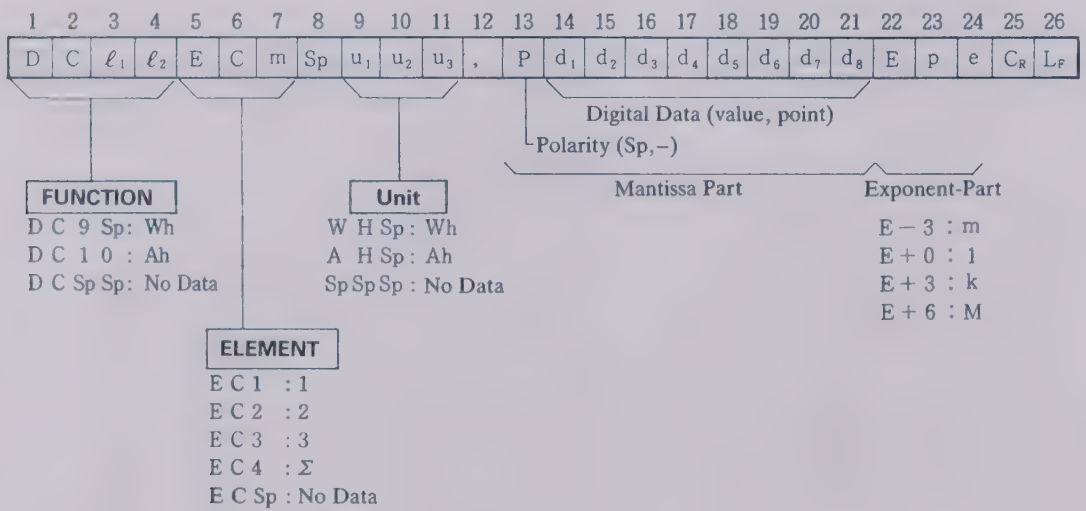
2-2-7. Operation Control for Integrator Function (page 2-13)

3-2. Data Output Format (page 3-3)

Also refer to the following items.

Output Format for Integrated Value

The integrated value is output when OI command is received after the integration has ended by time-out. Once the integrated data are read, the data cannot be read until the next time-out (become 0). In a continuous integration mode, the integrated value immediately before reset is output.


1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26
D C ℓ1 ℓ2 E C m Sp u1 u2 u3 , P d1 d2 d3 d4 d5 d6 d7 d8 E p e CR LF
Digital Data (value, point)
Polarity (Sp,−)
Mantissa Part
Exponent-Part
FUNCTION
D C 9 Sp: Wh
D C 1 0 : Ah
D C Sp Sp: No Data
Unit
W H Sp : Wh
A H Sp : Ah
Sp Sp Sp : No Data
E − 3 : m
E + 0 : 1
E + 3 : k
E + 6 : M
ELEMENT
E C 1 : 1
E C 2 : 2
E C 3 : 3
E C 4 : Σ
E C Sp : No Data

3. REFERENCE INFORMATION

Error Codes

The table below indicates error numbers displayed by self-test when turning on power and error codes output by GP-IB interface.

Error Code Lists

Error No.	Error Contents	Operation of 2533E
Self-test, Initial Set when Turning on Power		
001	RAM (U4) is faulty	Err 001 is indicated on DISPLAY C and control is held
002	ROM (U2) is faulty	Err 002 is indicated on DISPLAY C and control is held
003	ROM (U3) is faulty	Err 003 is indicated on DISPLAY C and control is held
004	Board combination error (A-D converter board is absent or input board combination is erroneous)	Err 004 is indicated on DISPLAY C and control is held
005	Internal switch setting error (1, 2 turned ON)	Err 005 is indicated on DISPLAY C and control is held
006	On triple phase model internal switches are set to 3 voltages, 3 currents measurement	Err 006 is indicated on DISPLAY C and control is held
For GP-IB		
	A-D end	• At HOLD, A-D End SRQ is delivered
	INTEG end	• INTEG End SRQ is delivered
	INTEG Busy	• INTEG Busy Status is set
	INTEG Ready	• INTEG Busy Status is reset
100	Command error (undefined command is received)	• Service request SRQ is generated (syntax error) • When OE command is received, ERR 100 C_R L_F is sent
101	Parameter • Parameter is beyond specified range • DISPLAY and mode combination error	• Service request SRQ is generated (syntax error) • When OE command is received, ERR 101 C_R L_F is sent • In case of combination error, lamp of designeated function flashes
102	It is attempted to set timer or scaling at integration reserve status	• Service request SRQ is generated (syntax error) • When OE command is received, ERR 102 C_R L_F is sent

Error No.	Error Contents	Operation of 2533E
For GP-IB		
107	• While message (setting information, error No.) is output, A-D start is executed form GP-IB controller at sample HOLD status • A-D conversion start is executed by "ST", "TRG" while not at HOLD status • It is attempted to set range in auto range mode • It is attempted to set timer while timer or scaling is set • It is attempted to set scaling while timer or scaling is set	• Service request SRQ is generated (syntax error) • When OE command is received, ERR 107 (C_R)(L_F) is sent
110	It is attempted to start while integrator is reserved in another mode	• Service request SRQ is generated (syntax error) • When OE command is received, ERR 110 (C_R)(L_F) is sent
111	It is attempted to start integration when measurement data corresponding to integration mode have overflowed	• Service request SRQ is generated (syntax error) • When OE command is received, ERR 111 (C_R)(L_F) is sent
112	• It is attempted to start integration while integration is in progress • It is attempted to start integration when not in integration mode	• Service request SRQ is generated (syntax error) • When OE command is received, ERR 112 (C_R)(L_F) is sent
113	Itegration stop by integration over	• Service request SRQ is generated (syntax error) • When OE command is received, ERR 113 (C_R)(L_F) is sent
114	• It is attempted to reset integration while integration is in progress • It is attempted to reset integration when not in integration mode	• Service request SRQ is generated (syntax error) • When OE command is received, ERR 114 (C_R)(L_F) is sent
116	It is attempted to reset integration when display is not in integration mode	• Service request SRQ is generated (syntax error) • When OE command is received, ERR 116 (C_R)(L_F) is sent

Error No.	Error Contents	Operation of 2533E
Processing error		
103	Result of scaling factor computation overflows display digits	• "(8) 888888 "is indicated on corresponding display • Service request SRQ is generated (OVER) • When OE command is received, ERR 103 (CR)(LF) is sent
104	Measured data over (input of A-D converter exceeds 140% of rated range)	• " 99999 " is indicated on corresponding display • Service request SRQ is generated (OVER) • When OE command is received, ERR 104 (CR)(LF) is sent
105	No measurement data	• "(-) - - - - - - "is indicated on corresponding display • Service request SRQ is generated (OVER) • When OE command is received, ERR 105 (CR)(LF) is sent
106	Voltage peak value over (voltage peak value exceeds 250% of rated range)	• Voltage PEAK OVER lamp comes on • Service request SRQ is generated (OVER) • When OE command is received, ERR 106 (CR)(LF) is sent
108	Current peak value over (current peak value exceeds 350% of rated range)	• Current PEAK OVER lamp comes on • Service request SRQ is generated (OVER) • When OE command is received, ERR 108 (CR)(LF) is sent
109	Frequency data are under	• "9999999"is indicated on DISPLAY C • Service request SRQ is generated (OVER) • When OE command is received, ERR 109 (CR)(LF) is sent
Hardware Error		
200	A-D converter error	"Err 200"is indicated on DISPLAY C and control is held. A-D board is faulty.
201	Integrator error	"Err 201 "is indicated on DISPLAY C and control is held. INTEG board is faulty.
202	Frequency measuring section error	"Err 202"is indicated on DISPLAY C and control is held. FRQ board is faulty.
Data Setting Error		
	Scaling factor set value is beyond setting range (0.0001 to 10000)	"(8) 888888 "is indicated on relevant display section and entire display flashes
	Timer set value is beyond setting range (00 h: 01 min to 999 h: 00 min)	"(8) 888888 "is indicated on relevant display section and entire display flashes

4. SCHEMATIC DIAGRAMS AND ELECTRONIC PARTS LIST

Par.	Description	Ass'y No.	Fig. No.	Page
1	FRQ. Board Ass'y Schematic Diagram	B9278JR	4-1a	4–2
	FRQ. Board Ass'y Components Location Diagram		4-1b	4–3
	FRQ. Board Ass'y Electronic Parts List		——	4–3
2	INTEG. Board Ass'y Schematic Diagram (1/2)	B9278JS	4-2a	4–4
	INTEG. Board Ass'y Schematic Diagram (2/2)		4-2b	4–5
	INTEG. Board Ass'y Components Location Diagram		4-2c	4–6
	INTEG. Board Ass'y Electronic Parts List		——	4–7

INDEX

List of abbreviations

AC	alternating current	IC	integrated circuit	RTD	resistance temperature detector
ADPTR	adapter	IND	inductance, induction	RTRY	rotary
Aℓ	aluminum	ISLN	isolation		
AMP	amplifier	ISOL	isolator	SEG	segment
ASSY	assembly	JIS	Japanese industrial standard	SHLD	shielded
BAT	battery	JUMP	jumper	Si	silicon
BFR	buffer	L	inductor	SKT	socket
BUZ	buzzer	LCD	liquid crystal display	SNSR	sensor
CAP	capacitor	LED	light-emitting diode	SPLY	supply
CAR	carbon	LSI	large-scale integrated circuit	STAB	stabilizer
CBL	cable	MDL	module	STD	standard
CCT	circuit	MET	metal (lized)	STEPG	stepping
CER	ceramic	MOD	modulator	SVO	servo
CHP	chopper	NOM VAL	nominal value	SW	switch
CNTR	counter	OPT	optical	SYN	synchronous
COAX	coaxial	OSC	oscillator	Ta	tantalum
COM	common	PB	printed board	TC	thermocouple
COMP	composition	PBA	printed board assembly	TEMP	temperature
CONN	connector	PEC	photoelectric cell	TERM	terminal
CONV	converter	POLYE	polyester	TGL	toggle
CT	current transformer	POLYS	polystyrene	THERMO	thermostat
DC	direct current	POT	potentiometer	THMS	thermistor
DET	detector	PT	potential transformer	UJT	unijunction transistor
DSPL	display	PWR	power	VAR	variable
ELECT	electrolytic	RAM	random access memory	WW	wire wound
EXT	external, extension	RBN	ribbon	XDCR	transducer
FET	field effect transistor	RECP	receptacle	XFMR	transformer
FLEX	flexible	RECT	rectifier	XSTR	transistor
FLM	film	RES	resistor	XTAL	crystal
FLTR	filter	RGLTR	regulator	ZNR	zener
FXD	fixed	ROM	read only memory		
Ge	germanium				
GEN	generator				
GND	ground				

Example

CONN : multi = multi connector
CAP : fxd Al elect = Fixed aluminum electrolytic capacitor
CAP : fxd polye flm = Fixed polyester film capacitor
RES : fxd car flm = Fixed carbon film resistor
RES : var ww = Wirewound variable resistor
SW : rtry = rotary switch

NOTES

1. Components — especially ICs — which are equivalent to components shown in the schematic diagrams and parts list, but manufactured by other manufacturers, can in general be used in the instrument.
2. Subject to change without notice; changes may be made to improve the instrument's performance.

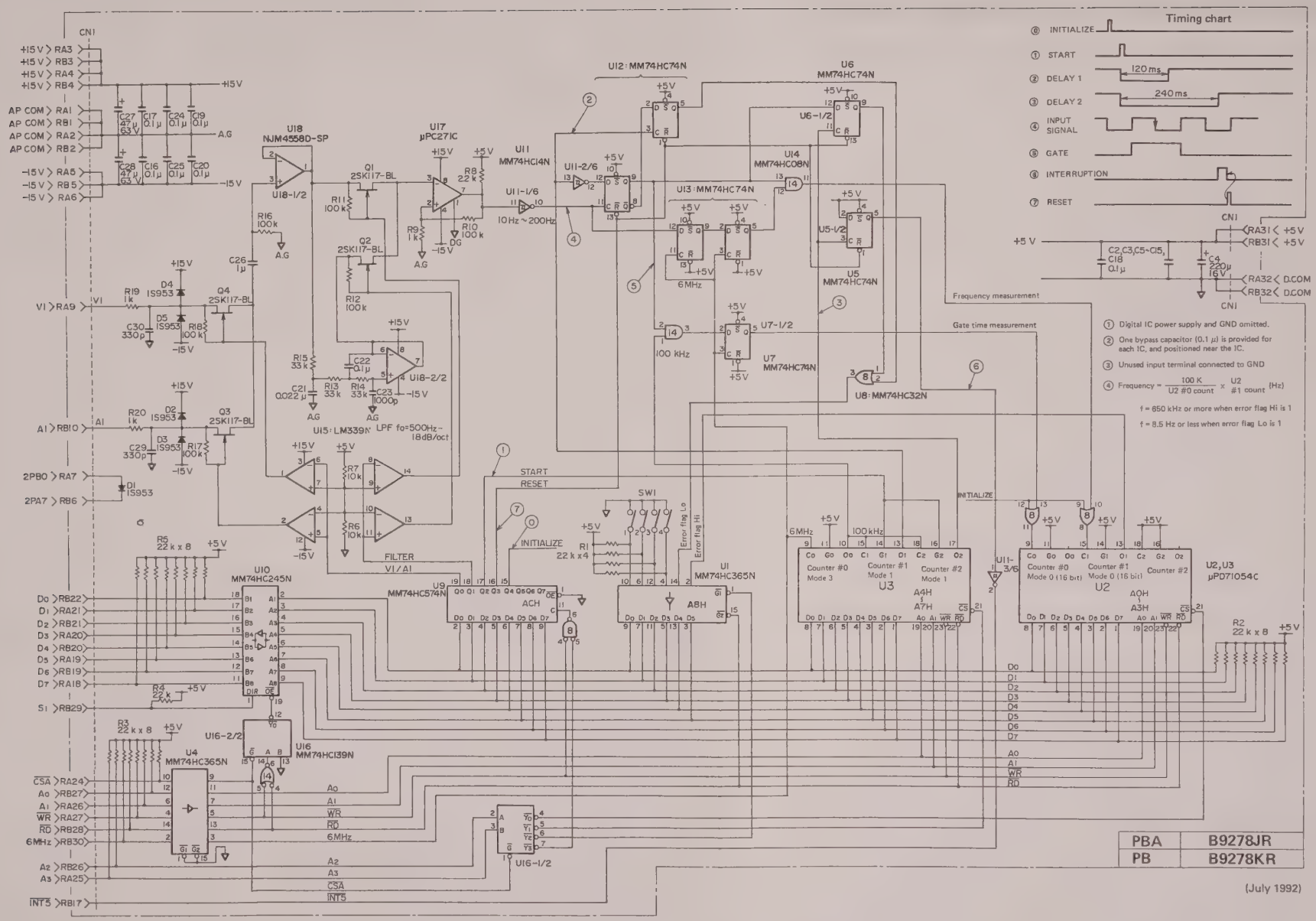
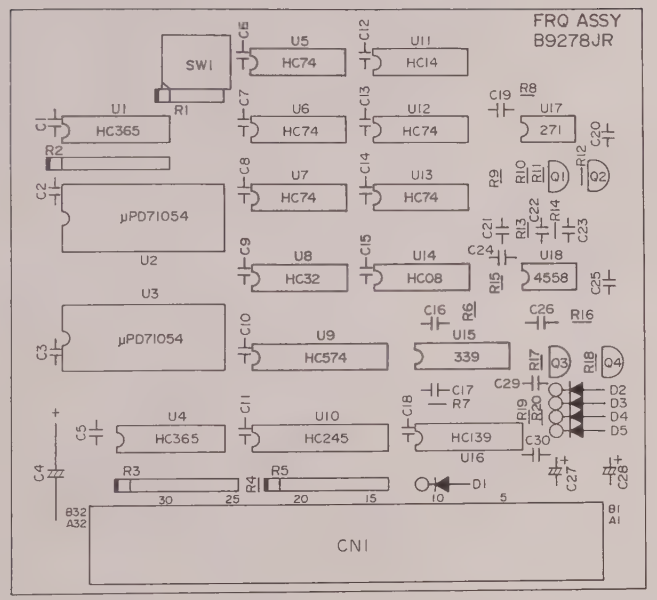

Timing chart
INITIALIZE
START
DELAY 1
120 ms
DELAY 2
240 ms
INPUT SIGNAL
GATE
INTERRUPTION
RESET
Frequency measurement
Gate time measurement
1 Digital IC power supply and GND omitted.
2 One bypass capacitor (0.1 μ) is provided for each IC, and positioned near the IC.
3 Unused input terminal connected to GND
4 Frequency = 100 K / U2 #0 count × U2 #1 count (Hz)
f = 650 kHz or more when error flag Hi is 1
f = 8.5 Hz or less when error flag Lo is 1
PBA B9278JR
PB B9278KR
(July 1992)

Figure 4-1a. FRQ. Board Ass'y: B9278JR Schematic Diagram.



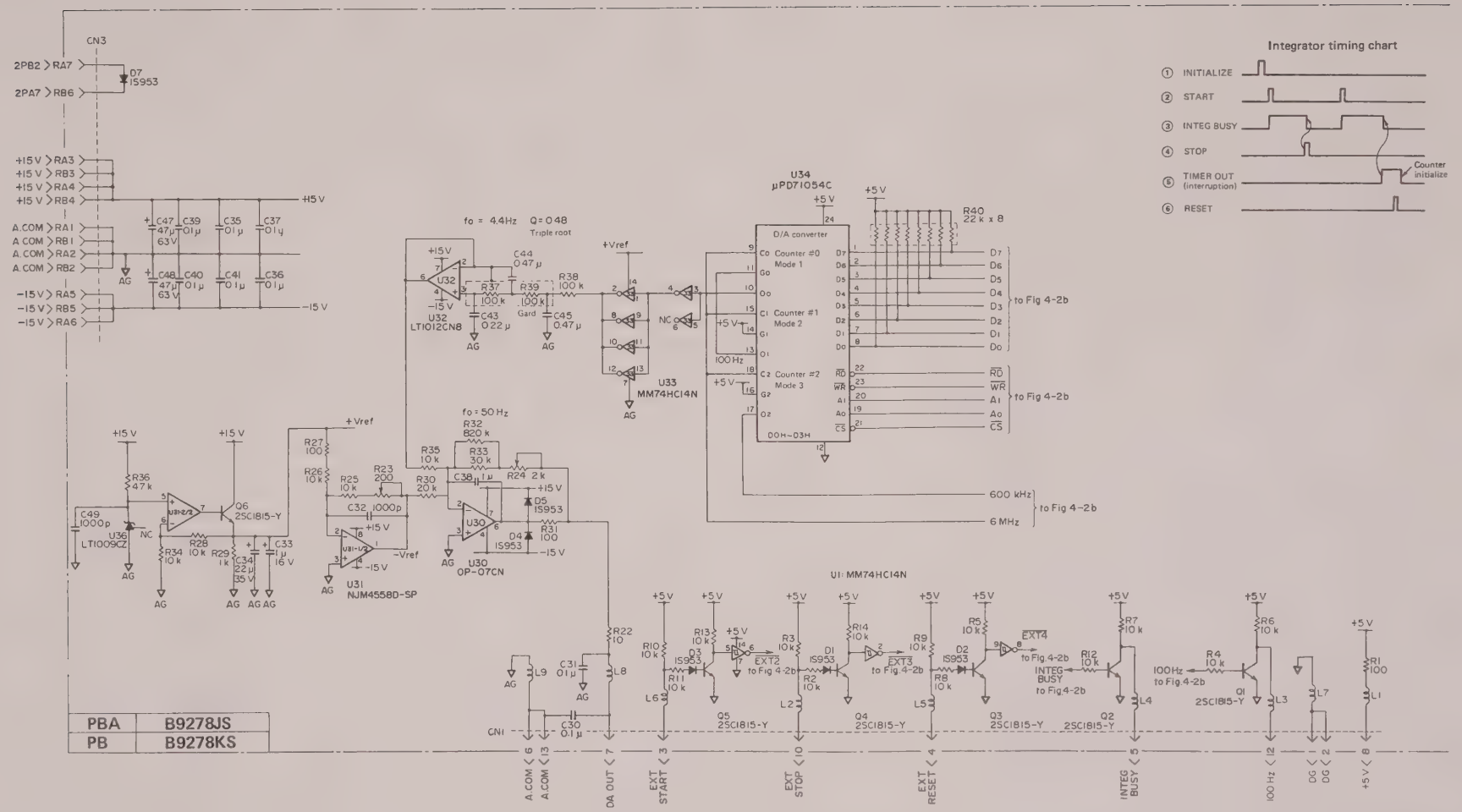
(July 1992)

Figure 4-1b. FRQ. Board Ass'y: B9278JR Components Location Diagram.

4-1. FRQ. Board Ass'y: B9278JR.

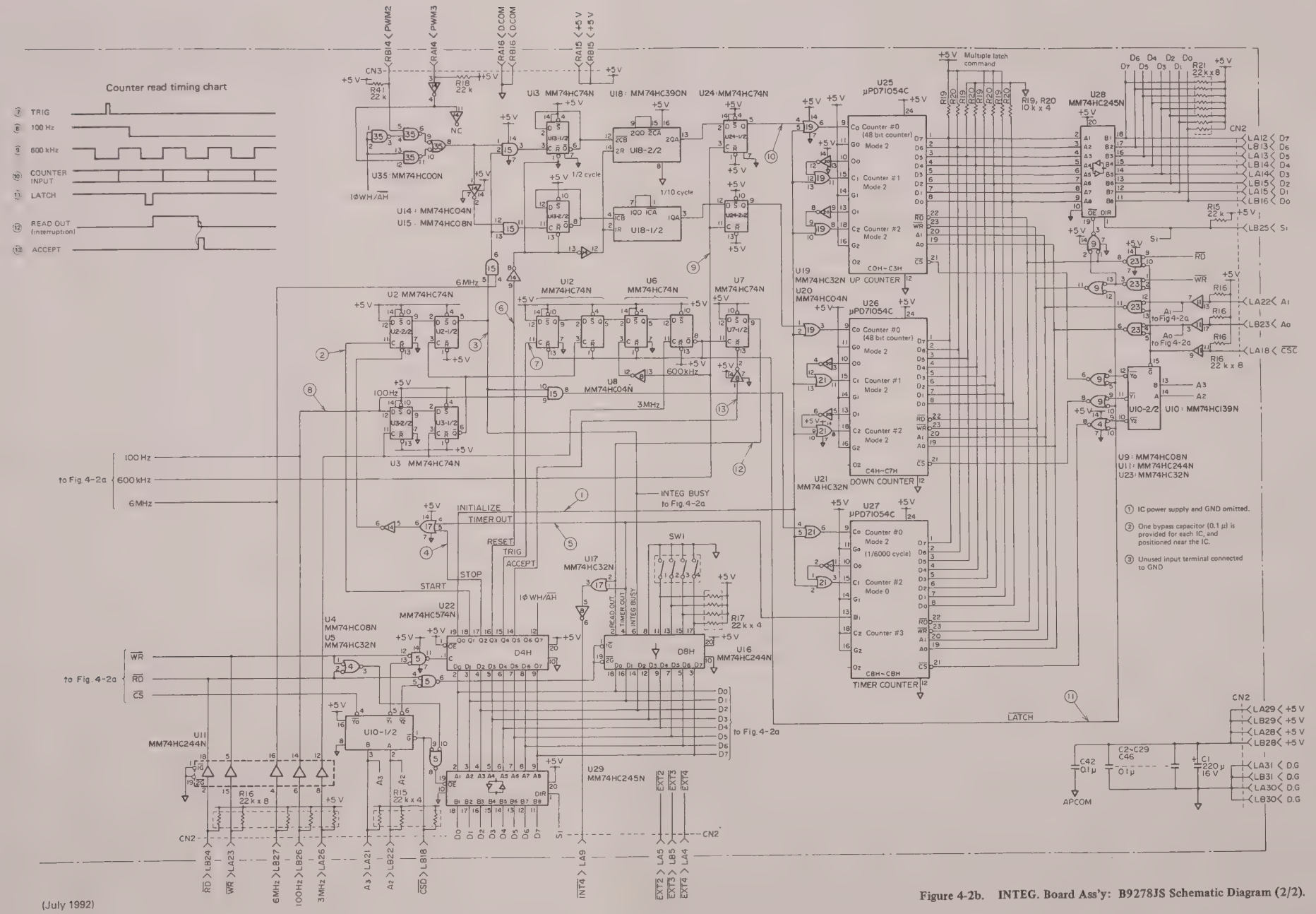
(July 1992)

Item	Part No.	Part Name and Description	Remarks
R1	A9041RL	Res: module 22kΩ ±5% 1/8W RKC1/8 B4 22kΩJ	4 elements
R2, R3	A9071RL	Res: module 22kΩ ±5% 1/8W RKC1/8 B8 22kΩJ	8 elements
R4	A9081RG	Res: fxd met flm 22kΩ ±1% ¼W LF¼ 22kΩF	
R5	A9071RL	Res: module 22kΩ ±5% 1/8W PKC1/8 B8 22kΩJ	8 elements
R6, R7	A9073RG	Res: fxd met flm 10kΩ ±1% ¼W LF¼ 10kΩF	
R8	A9057RG	Res: fxd met flm 2.2kΩ ±1% ¼W LF¼ 2.2kΩF	
R9	A9049RG	Res: fxd met flm 1kΩ ±1% ¼W LF¼ 1kΩF	
R10	A9097RG	Res: fxd met flm 100kΩ ±1% ¼W LF¼ 100kΩF	
R11, R12	A9097RG	Res: fxd met flm 100kΩ ±1% ¼W LF¼ 100kΩF	
R13~R15	A9085RG	Res: fxd met flm 33kΩ ±1% ¼W LF¼ 33kΩF	
R16~R18	A9097RG	Res: fxd met flm 100kΩ- ±1% ¼W LF¼ 100kΩF	
R19, R20	A9049RG	Res: fxd met flm 1kΩ ±1% ¼W LF¼ 1kΩF	
C1~C3	A9114CC	Cap: fxd cer 0.1µF 50V RPE132-305F104Z50	
C4	A9465CA	Cap: fxd Al elect 220µF 16V ECEB1CU221	
C5~C10	A9114CC	Cap: fxd cer 0.1µF 50V RPE132-305F104Z50	
C11~C20	A9114CC	Cap: fxd cer 0.1µF 50V RPE132-305F104Z50	
C21	A9252CY	Cap: fxd polye flm 0.22µF ±10% 50V MFL5002-223K	
C22	A9366CY	Cap: fxd polye flm 0.1µF ±10% 63V 553M6302-104K	
C23	A9244CY	Cap: fxd polye flm 1000pF ±10% 50V MFL5002-102K	
C24, C25	A9114CC	Cap: fxd cer 0.1µF 50V RPE132-305F104Z50	
C26	A9371CY	Cap: fxd polye flm 1µF ±10% 50V 553M5002 105K	
C27, C28	A9455CA	Cap: fxd Al elect 47µF 63V ECEA1JU470	
C29, C30	A9032CN	Cap: fxd mica 330pF ±10% 100V DM05C 331K1	
D1~D5	A9248HD	Diode: Si 1S953	
Q1~Q4	A9413HQ	FET 2SK117-BL	
U1	A9062LN	IC: digital MM74HC365N	CMOS
U2, U3	A9052LC	LSI: programmable timer, counter µPD71054C	
U4	A9062LN	IC: digital MM74HC365N	CMOS
U5~U7	A9014LN	IC: digital MM74HC74N	CMOS
U8	A9011LN	IC: digital MM74HC32N	CMOS
U9	A9076LN	IC: digital MM74HC574N	CMOS
U10	A9052LN	IC: digital MM74HC245N	CMOS
U11	A9007LN	IC: digital MM74HC14N	CMOS
U12, U13	A9014LN	IC: digital MM74HC74N	CMOS
U14	A9004LN	IC: digital MM74HC08N	CMOS
U15	A9019LA	IC: analog LM339N	
U16	A9027LN	IC: digital MM74HC139N	CMOS
U17	A9085LA	IC: analog µPC271C	
U18	A9195LA	IC: analog NJM4558D-SP	
SW1	A9157SS	Sw: toggle A6DR-4100-05	
CN1	A9708KP	Conn PCN10A-64P-2.54DS	
	B9278FJ	Blcok (1 pc)	
	B9278FK	Block (1 pc)	
	Y9308LB	Screw: M3 X 8 (1 pc)	
	Y9301CB	Nut: M3 (1 pc)	
	B9278KR	PB (1 pc)	



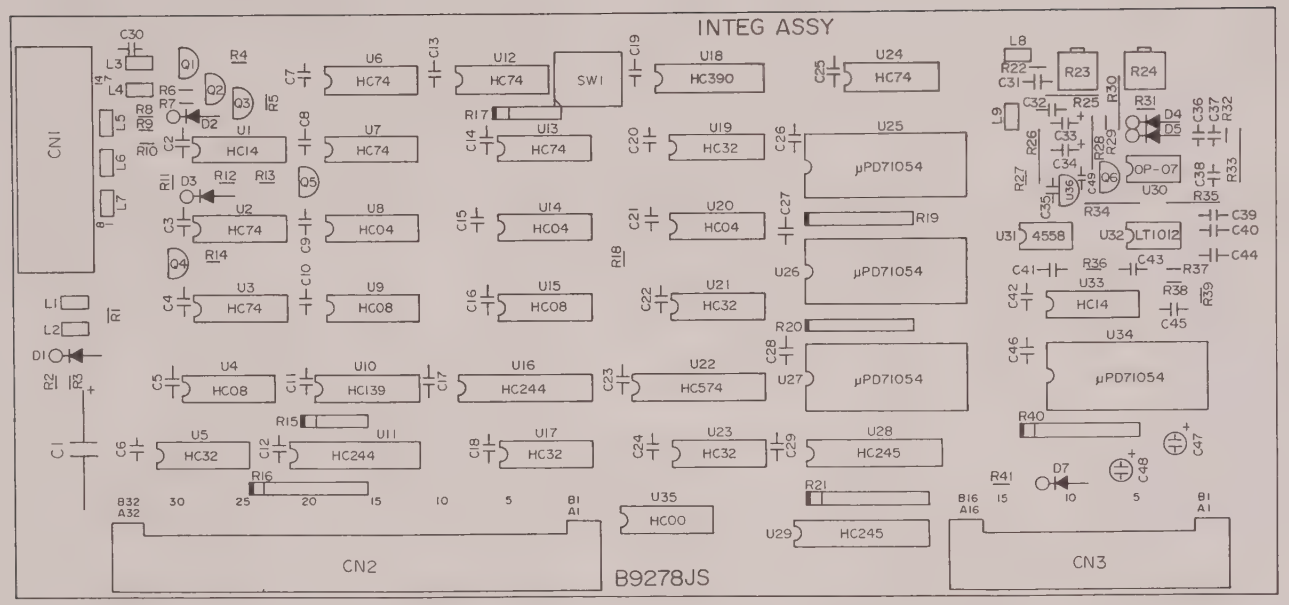
(July 1992)

Figure 4-2a. INTEG. Board Ass'y: B9278JS Schematic Diagram (1/2).



(July 1992)

Figure 4-2b. INTEG. Board Ass'y: B9278JS Schematic Diagram (2/2).



(July 1992)

Figure 4-2c. INTEG. Board Ass'y: B9278JS Components Location Diagram.

4-2. INTEG. Board Ass'y: B9278JS. (July 1992)

Item	Part No.	Part Name and Description	Remarks
R1	A9025RG	Res: fxd met flm 100Ω ±1% ¼W LF¼ 100ΩF	
R2~R10	A9073RG	Res: fxd met flm 10kΩ ±1% ¼W LF¼ 10kΩF	
R11~R14	A9073RG	Res: fxd met flm 10kΩ ±1% ¼W LF¼ 10kΩF	
R15	A9041RL	Res: module 22kΩ ±5% 1/8W RKC1/8 B4 22kΩJ	4 elements
R16	A9071RL	Res: module 22kΩ ±5% 1/8W RKC1/8 B8 22kΩJ	8 elements
R17	A9041RL	Res: module 22kΩ ±5% 1/8W RKC1/8 B4 22kΩJ	4 elements
R18	A9081RG	Res: fxd met flm 22kΩ ±1% ¼W LF¼ 22kΩF	
R19, R20	A9115RL	Res: module 10kΩ ±5% ¼W RKC¼B4S 10kΩJ	4 elements
R21	A9071RL	Res: module 22kΩ ±5% 1/8W RKC1/8 B8 22kΩJ	8 elements
R22	A9001RG	Res: fxd met flm 10Ω ±1% ¼W LF¼ 10ΩF	
R23	A9543RV	Res: var cermet 200Ω ±20% ¼W GF06X1 200Ω	
R24	A9544RV	Res: var cermet 2kΩ ±20% ¼W GF06X1 2kΩ	
R25, R26	A9653RK	Res: fxd met flm 10kΩ ±0.1% ¼W CFA10kΩBT1	
R27	A9025RG	Res: fxd met flm 100Ω ±1% ¼W LF¼ 100ΩF	
R28	A9653RK	Res: fxd met flm 10kΩ ±0.1% ¼W CFA10kΩBT1	
R29	A9049RG	Res: fxd met flm 1kΩ ±1% ¼W LF¼ 1kΩF	
R30	A9656RK	Res: fxd met flm 20kΩ ±0.1% ¼W CFA20kΩBT1	
R31	A9025RG	Res: fxd met flm 100Ω ±1% ¼W LF¼ 100ΩF	
R32	A9119RG	Res: fxd met flm 820kΩ ±1% ¼W LF¼ 820kΩF	
R33	A9670RK	Res: fxd met flm 30kΩ ±0.1% 1/8W CFA30kΩBT1	
R34, R35	A9653RK	Res: fxd met flm 10kΩ ±0.1% ¼W CFA10kΩBT1	
R36	A9065RG	Res: fxd met flm 4.7kΩ ±1% ¼W LF¼ 4.7kΩF	
R37~R39	A9097RG	Res: fxd met flm 100kΩ ±1% ¼W LF¼ 100kΩF	
R40	A9071RL	Res: module 22kΩ ±5% 1/8W RKC1/8 B8 22kΩJ	8 elements
R41	A9081RG	Res: fxd met flm 22kΩ ±1% ¼W LF¼ 22kΩF	
C1	A9465CA	Cap: fxd Al elect 220μF 16V ECEB1CU221	
C2~C10	A9114CC	Cap: fxd cer 0.1μF 50V RPE132-305F104Z50	
C11~C20	A9114CC	Cap: fxd cer 0.1μF 50V RPE132-305F104Z50	
C21~C30	A9114CC	Cap: fxd cer 0.1μF 50V RPE132-305F104Z50	
C31	A9114CC	Cap: fxd cer 0.1μF 50V RPE132-305F104Z50	
C32	A9244CY	Cap: fxd polye flm 1000pF ±10% 50V MFL5002-102K	
C33	A9233CT	Cap: fxd Ta elect 1μF 16V CS90E-1V-1R000-R58	
C34	A9441CA	Cap: fxd Al elect 22μF 35V ECEA1VU220	
C35~C37	A9114CC	Cap: fxd cer 0.1μF 50V RPE132-305F104Z50	
C38	A9371CY	Cap: fxd polye flm 1μF ±10% 50V 553M5002 105K	
C39, C40	A9114CC	Cap: fxd cer 0.1μF 50V RPE132-305F104Z50	
C41, C42	A9114CC	Cap: fxd cer 0.1μF 50V RPE132-305F104Z50	
C43	A9367CY	Cap: fxd polye flm 0.22μF ±10% 63V 553M6302 224K	
C44, C45	A9369CY	Cap: fxd polye flm 0.47μF ±10% 63V 553M6302 474K	
C46	A9114CC	Cap: fxd cer 0.1μF 50V RPE132-305F104Z50	
C47, C48	A9455CA	Cap: fxd Al elect 47μF 63V ECEA1JU470	
C49	A9244CY	Cap: fxd polye flm 1000pF ±10% 50V MFL5002-102K	

4-2. INTEG. Board Ass'y: B9278JS. (continued)

Item	Part No.	Part Name and Description	Remarks
L1~L9	A9100MC	FLTR ZBF253D-01	
D1~D5	A9248HD	Diode: Si 1S953	
D6			not assigned
D7	A9248HD	Diode: Si 1S953	
Q1~Q6	A9340HQ	XSTR 2SC1815-Y	
U1	A9007LN	IC: digital MM74HC14N	CMOS
U2, U3	A9014LN	IC: digital MM74HC74N	CMOS
U4	A9004LN	IC: digital MM84HC08N	CMOS
U5	A9011LN	IC: digital MM74HC32N	CMOS
U6, U7	A9014LN	IC: digital MM74HC74N	CMOS
U8	A9003LN	IC: digital MM74HC04N	CMOS
U9	A9004LN	IC: digital MM74HC08N	CMOS
U10	A9027LN	IC: digital MM74HC139N	CMOS
U11	A9051LN	IC: digital MM74HC244N	CMOS
U12, U13	A9014LN	IC: digital MM74HC74N	CMOS
U14	A9003LN	IC: digital MM74HC04N	CMOS
U15	A9004LN	IC: digital MM74HC08N	CMOS
U16	A9051LN	IC: digital MM74HC244N	CMOS
U17	A9011LN	IC: digital MM74HC32N	CMOS
U18	A9068LN	IC: digital MM74HC390N	CMOS
U19	A9011LN	IC: digital MM74HC32N	CMOS
U20	A9003LN	IC: digital MM74HC04N	CMOS
U21	A9011LN	IC: digital MM74HC32N	CMOS
U22	A9076LN	IC: digital MM74HC574N	CMOS
U23	A9011LN	IC: digital MM74HC32N	CMOS
U24	A9014LN	IC: digital MM74HC74N	CMOS
U25~U27	A9052LC	LSI: programmable timer, counter μPD71054C	
U28, U29	A9052LN	IC: digital MM74HC245N	CMOS
U30	A9200LA	IC: analog OP-07CN	
U31	A9195LA	IC: analog NJM4558D-SP	
U32	A9188LA	IC: analog LT1012CN8	
U33	A9086LN	IC: digital MM74HC14N	CMOS
U34	A9052LC	LSI: programmable timer, counter μPD71054C	
U35	A9001LN	IC: digital MM74HC00N	CMOS
U36	A9211LA	IC: analog LT1009CZ	
SW1	A9130SS	Sw: toggle DNP-4	
CN1	A9636KC	Conn 57LE-40140-7700-D12	
CN2	A9708KP	Conn PCN10A-64P-2.54DS	
CN3	A9709KP	Conn PCN10A-32P-2.54DS	
	B9278DZ	Plate (1 pc)	
	Y9310JB	Screw: M3 X 10 (2 pcs)	
	Y9308LB	Screw: M3 X 8 (2 pcs)	
	B9278KS	PB (1pc)	

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